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X. *On the Comparative Anatomy of the Thyroid Gland.* By JOHN SIMON, Esq., Assistant-Surgeon to the King's College Hospital, and Demonstrator of Anatomy in King's College. Communicated by JOSEPH HENRY GREEN, Esq., F.R.S., Senior Surgeon to St. Thomas's Hospital, Professor of Anatomy to the Royal Academy, &c. &c. &c.

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FEW portions of comparative anatomy appear in a less satisfactory condition than that relating to the organs which have been classed together as glands without ducts. Since any attempt to illustrate the obscure physiology of these bodies must of necessity be founded on a precise knowledge of their distribution in the animal kingdom, the deficiency cannot be considered unimportant; and I accordingly venture to hope that the following details may not appear devoid of interest to the Royal Society.

In recent researches I have had occasion to examine how far the presence of a *thymus gland* extends in the scale of organization: in the present paper I confine myself to the comparative anatomy of the *thyroid body*; and I hope, on some future opportunity, to communicate the result of similar investigations in regard of the remaining two organs of the class, viz. the *spleen* and *supra-renal capsule*.

In pursuing the present subject, and particularly in that part of it which treats of Reptiles, I have been under the greatest obligation to my friend Mr. GRAY of the British Museum, by whose kindness I have enjoyed opportunities of examining many animals which I could not otherwise have procured. I have likewise owed much to the liberality of the Council of the Royal College of Surgeons, who have permitted me access to their rich assortment of store-preparations.

The careful dissections of MECKEL and CUVIER (as recorded in the former's *Abhandlungen aus der menschlichen u. vergleichenden Anatomie u. Physiologie*, Halle, 1806, and in the latter's celebrated lectures) leave no question as to the universal existence of a thyroid gland in the class of mammiferous animals. It is therefore unnecessary to dwell upon this point, and I proceed at once to consider the anatomy of the gland in the other classes of Vertebrata.

I. *Birds.*

Some writers on the comparative anatomy of Birds have described "two glands, one on each side of the trachea, very near the lower larynx, and frequently attached to the jugular veins; which they regard as the analogues of the thyroid gland*."

* OWEN in *Cyclop. of Anat.* vol. i. p. 348; CARUS, *Vergleich. Anat.* § 741.

They were first, I believe, mentioned by PERRAULT*, and were afterwards described in several genera of Birds by BALLANTI† and UTTINI. Various later observers have since noticed these bodies; some considering them as thyroid glands; while others, among whom are MECKEL, CUVIER and HAUGSTED, entertain a different opinion of their nature.

In all such uncertainties the microscope is the only conclusive test. By repeated and careful examinations, I have satisfied myself that the ultimate structure of these doubtful organs is identical with that of the thyroid gland in Mammalia. They consist, namely, of a dense aggregation of closed vesicles, whereof each is constituted by a delicate homogeneous membrane, is invested by a close capillary net-work, and contains in its interior either floating cytoblasts, or mature cells, corresponding to those of the true glands.

My dissections of Birds have included all the orders, and, in most instances, several families from each: I have never failed to find the thyroid gland, or to recognise its peculiar structure: I accordingly presume that it is universally present in this class of animals.

Of its relative position it is unnecessary to say much more than is included in the notices of previous observers, and I will merely mention that its relation to the larynx seems neither essential nor constant. A more uniform and more important relation is included in the fact, that the gland always corresponds to a particular spot of the vascular system; namely, that it lies on the cervical vessels, and receives its supply of blood just opposite to the point at which the vertebral and carotid arteries diverge to their respective destinations.

II. *Reptiles.*

It is unaccountable that in this class of animals, where the thyroid gland is universally manifest, it should have been so generally overlooked. Where noticed, it has been, with rare and partial exceptions, either mistaken for the thymus, or confounded with it in a common description.

A. *Chelonia.*

BOJANUS, in his excellent monograph on the freshwater Tortoise‡, figures with perfect fidelity the body, which I shall directly mention as the thyroid gland; but he does so under the erroneous impression that it is a thymus, and describes it by this name: CARUS§ likewise falls into the same error as to its true nature.

* *Déscription de six Otardes*, Mém. de l'Acad. t. iii. part 2. p. 319.

† BALLANTI states an opinion of their use which has received pretty general sanction:—"quod vocis organo famuletur glandula hujusmodi in animantibus, id videtur satis comprobare ejus sedes, quæ nunquam non est cum eo organo conjuncta;" and UTTINI, who continued his researches, specifies this function more exactly, as being "ad vocales chordas opportune emolliendas et humectandas." *Comment. Bonon.* 1783; *De Organo Vocis.*

‡ *Anat. testudinis Europ.* figs. 66, 156, 173.

§ *Op. cit.* § 740.

The position of the thyroid in this order of Reptiles is very definite and uniform ; it lies in the median plane of the body, just above the base of the heart, between the right and left carotid arteries. The thymus, for which it has been mistaken, lies away from the median line, along the outer side of the carotid on each side, between it and the subclavian artery.

B. *Emydosauria*.

In this order the thyroid gland is a single rounded organ, situate in the median plane of the body immediately above the base of the heart. A careful dissection in this region will first bring into view the thymus gland, which reaches on each side from just below the skull to within the thorax, and conceals the thyroid by the expansion of its pericardiac lobes in front of the base of the heart ; these being drawn aside the thyroid gland will be distinctly seen lying between the two carotid arteries. CARUS* notices the elongated thymus of the Crocodile, and proposes the vague opinion that it may perhaps fulfil the double function of thymus and thyroid.

C. *Amphisbænia*.

The thyroid gland in the Amphisbænians occupies exactly the same site and relations as in the true Serpents.

D. *Sauria*.

In this order it is not quite so easy as in the preceding ones to verify the existence of the gland, for it occupies different positions in different families, and is therefore very likely to elude superficial search : in some it is single and mesial, in others double ; in some it lies high in the neck, in others low.

1. Among the *Lacertidæ*, the arrangement of the gland is not quite constant for the family. In the true Lizards, and in the Teius, the gland is single, and of considerable transverse diameter, being so situated as to overbridge the trachea a little above the chest : in the Monitors, on the contrary, it is double ; one portion is placed on each side of the neck, in front of the carotid artery, and is connected with the inferior extremity of the corresponding half of the thymus gland.

2. Among the *Iguanidæ* likewise the anatomical relations of the gland are not quite uniform : in the *Agamæ* and *Iguanæ* it is single, and lies transversely across the trachea ; while in the *Istiurus*, as in the Monitors, it consists of two portions, one lying in front of each carotid low in the neck.

3, 4, 5. Among the *Geckotidæ*, *Chamæleonidæ* and *Scincidæ*, the same general form prevails as in the true Lizards ; the gland is single, and elongated transversely so as to reach across the trachea. In the Chamæleon it is rather higher (nearer to the os hyoides) than in the other families, and is overhung by the sacciform dilatation of the larynx. TREVIRANUS†, in his dissection of the *Chamæleo carinatus*, noticed this body, and suggests of it that it “ may be compared to a thyroid gland.”

* *Op. cit.* § 740.

† Beobachtungen aus der Zootomie, p. 87.

E. *Ophidia*.

In the true Serpents the thymus and thyroid are in such close juxtaposition, and are in many genera so additionally obscured by the presence of a large fat body, that it is not easy to judge, from the vague descriptions of authors, how far the thyroid gland itself has actually been discerned. The organ which BLASIUS* described as a thymus “*vasis circa collum situatis accumbens, firmæ admodum conditionis, hordei magnitudinem vix excedens,*” was probably the thyroid gland; CHARAS† likewise figured it faithfully, though with the same mistake as to its nature. CUVIER had certainly dissected it, and describes its exterior conformation with his wonted accuracy, stating his impression that it is “analogous to the thyroid gland.”

The following description applies to all the true Serpents:—The gland lies, as in the Crocodile, just above the base of the heart, between the right and left carotid arteries: it is a little hidden by the thymus of each side, which lies on the carotid for some distance from the pericardium upwards; and in those genera which possess a fat body (as is, for example, eminently the case with the Python) this large organ lies conspicuously in front of both the thymus and thyroid.

F. *Batrachia*.

Among Batrachia, CARUS‡ has recognized the thyroid glands of the common Frog; but his statement of their nature appears, like most of the opinions I have quoted, to be delivered vaguely and with hesitation. The organs which he represents are unquestionably thyroid glands; they are situated on the carotid arteries, just beside the cornua of the hyoid bone, one on each side. HUSCHKE, in adopting CARUS's description, suggests that these bodies probably have their origin in the shrinking of the branchiæ, and he proceeds to apply the theory so obtained to the thyroid gland in other animals, stating the common mode of origin of this organ to lie in the transformation of the branchial arches in the early embryo§. But this hypothesis appears sufficiently refuted by the anatomy of the *Menobranchus lateralis*; for in this perennibranchiate reptile the thyroid gland exists no less certainly than in those which possess the branchial apparatus only for a time. I have found the gland in this animal, consisting of two symmetrical portions connected with the inferior border of the os hyoides, one on each side, at the junction of the body and lateral portions of that bone. In the *Menopoma* I have likewise detected the gland, occupying nearly the same relative position as in the *Menobranchus*. In the *Siren* and *Proteus* I have had no opportunity of making satisfactory examinations.

In the Salamandridæ the same arrangement prevails as in the Ranidæ.

In the anomalous *Lepidosiren paradoxa* the thyroid gland appears also to exist.

* Anat. Animalium, Amst. 1681.

† Loc. cit.

‡ Nouvelles Expériences sur la Vipère, ch. v. sect. 3. fig. 2. D.

§ Oken's Isis, 1826, p. 621.

BISCHOFF, in his elaborate dissection of that animal*, discovered a minute glandular organ, adjoining the anterior extremity of each isolated cornu of the os hyoides, and inclined to consider it as a salivary gland. I have had no opportunity of examining this rare reptile, but BISCHOFF's account is so complete and circumstantial as almost to supply the absence of personal observation. The minute body in question cannot be viewed as a salivary gland, for it is expressly stated by BISCHOFF to be destitute of an excretory duct. This last point almost decides its true place in the animal economy; and further, its position, in regard to the hyoid bone, is so exactly that occupied by the thyroid gland in the Menopoma and Menobranchus, that (from BISCHOFF's description) I cannot hesitate in ascribing to it the same nature.

III. *Fishes.*

I am not aware that any author has hitherto suggested the possible existence of a thyroid gland amongst this class of vertebrate animals.

In many fishes it is undoubtedly present; I have found it in the Carp (*Cyprinus*), Anableps†, Pike (*Esox*), Exocetus†, Cod (*Gadus*), Haddock (*Morrhua*), Whiting (*Merlangus*), Eel (*Anguilla*), Sturgeon (*Acipenser*), Callorhynchus†, Shark (*Squalus*), Skate (*Raia*), and questionably in the Lamprey (*Petromyzon*).

It has appeared, on the other hand, to be absent in the Perch (*Perca*), Mullet (*Mugil*), Gurnard (*Trigla*), Mackerel (*Scomber*), Tench (*Tinca*), Salmon (*Salmo*), Trout (*Salmo fario*), Herring (*Clupea*), Plaice (*Pleuronectes*), Holibut (*Hippoglossus*), Turbot (*Rhombus*), Sole (*Solea*), Cyclopterus, Gymnotus and Balistes†.

This part of my inquiry has been attended with extreme difficulty. According to varying circumstances the gland may occupy any one of three different positions;—these positions, moreover, related to each other (as would appear at first sight) by no very obvious analogy. It was long after discovering a thyroid gland in the Skate, and vainly searching for it in the corresponding region of the body in other fishes, that a second probable spot occurred to me, in which I succeeded in finding the gland in the Cod, Haddock and Whiting; and it was yet longer before I ascertained the organ's third occasional site. Such having been the case, it has of course been no easy matter to arrive at trustworthy results as to the absence or presence of the gland in each particular instance. In forming the negative conclusion, there was always some fear of having overlooked the organ,—always some doubt of its occupying an unexplored space. The positive certainty, which alone is valuable in investigations of this nature, cannot often be derived from examining preparations preserved in spirit; and, therefore, although I have made many such dissections, I refer to

* Lepidos. Parad. anatomisch untersucht und beschrieben, Leipzig, 1840.

† In those marked by a dagger, I have been obliged to trust to preparations preserved in spirit; and these dissections—especially with a negative result—are never quite so satisfactory as if performed on the recent body of the animal.

them in very few instances, and draw my inferences from those only which I can quote with entire confidence.

The positions in which I have found the gland are the following, viz.—

1. In those cartilaginous fishes* which possess it, as likewise in the Eel, it is a single organ, and is situated in the median line, in connexion with the anterior surface of the cartilages, which bind together the branchial arches of the opposite sides of the body. Within this line it may be more or less removed from the mouth of the animal, sometimes advancing so far upward as to come into contact with the lingual bone; but its position is always defined, as the spot where the great trunk of the branchial aorta distributes its terminal branches. It lies in the angle of this bifurcation, and sometimes (as in the Sturgeon) extends some little way behind it; it is covered by the sterno-hyoid or sterno-maxillary muscle, and also by the mylo-hyoid and genio-hyoid, when these are present. Situated at the anterior extremity of the first branchial arch, it receives its supply of blood by means of a recurrent branch given off in this direction by the first branchial vein, while yet within the gill. It never receives the smallest share of supply from the branchial artery with which it is in contact.

2. In the *Gadidæ* the gland is double; one portion lies on each side, not as in the last case, at the anterior extremity of the first branchial arch, but near its posterior or vertebral end. Here it occupies part of a recess which is bounded by the gill below, and above by the outer extremity of that transverse fold of mucous membrane which limits the extent of the palate; it is merely covered by mucous membrane, which leaves it apparent to the eye without need of any express dissection. Its vascular supply is reflected to it from the ophthalmic artery, which arises, before the formation of the systemic aorta, from the first branchial vein close to the origin of the proper encephalic artery.

3. In the Carp, Anableps, Pike and Exocetus, the gland is placed at the inner extremity of the same duplicature of mucous membrane, and more toward the palate, so as to lie upon the fibres of the pterygoid muscle. It requires more dissection, in order to be made apparent; in the Carp especially it is at considerable depth, being hidden by the extraordinary thickness of the soft palate, and imbedded between the surface of the pterygoid muscle and the outer extremity of the branchial bone.

Amid these differences in the relative anatomy of the gland there is constancy in respect of one point, which I am inclined to consider essential; the organ, whether placed in the median plane or otherwise, whether at the vertebral, or at the hyoidal extremity of the gill, is always so placed as to receive its blood from the first bran-

* The questionable trace of a thyroid, noticed in the *Petromyzon marinus*, was in a depression of the base of the skull, between the palate and the posterior confluence of the branchial veins; it would resemble the above in being single, but otherwise would be nearer to the thyroids of the osseous fishes.

chial vein, and is thus brought into connexion with the encephalic nervous centre by a certain community of vascular supply.

Nothing could at first sight appear more capricious and uncertain than the presence of the gland in fishes; it would seem almost hopeless to account for its being found in the Carp, yet not in the Tench; in the Eel, yet not in the Gymnotus, &c. Further research, however, tends to justify the belief that its distribution is governed by a simple and uniform law; namely, by the existence or non-existence of another organ, with which its presence alternates. Since this law, if discoverable, must be an important step toward ascertaining the function of the thyroid gland, I beg leave to offer a few observations on the organ alluded to.

In many fishes (take for instance any one of our common Acanthopterygii or Pleuronectæ) there exists a peculiar appendage to the branchial apparatus, first described by BROUSSONET*, and subsequently with more detail by MECKEL†. It has the aspect of a minute supplementary gill, and is situated between the outer extremity of the palatine duplicature of mucous membrane on the one hand, and the dorsal attachment of the first true gill on the other‡. It must not be confounded with the large opercular gill, found in some fishes (as for instance very largely in the Sturgeon), from which it essentially differs.

The vascular supply of this small appendage is a point of extreme interest in its history. Its vessels communicate on the one hand with the systemic veins about the base of the cranium, on the other, by a single long trunk with the first branchial vein. RATHKE§ and CUVIER|| consider the former to be its afferent, the latter its efferent vessel. But it surely must be erroneous to describe any part of the circulation in a fish as *commencing in a systemic vein, and attaining a branchial vein without having previously traversed the heart*: and I cannot doubt that the supply of this branchiola is after the analogy of organs in the systemic circulation,—that it commences, namely, in the branchial vein, and terminates in those veins which are conveying blood to the heart¶.

The supplementary gill occupies in those fishes which possess it, exactly the same relative position as the thyroid gland in the sub-brachian Malacopterygii: a careless examination of the Cod, Haddock, or Whiting, where the gland shines through the membrane, might almost lead an observer to suppose that the supplemental branchia was there, as in the Pleuronectæ; so similar is the arrangement in the two cases. Equally exact, according to the above argument, would be the agreement of the two

* Mém. de l'Acad., 1785, p. 174.

† Vergleich. Anat. vol. vi. p. 179.

‡ It is often a little obscured by the free edge of the palate overhanging it.

§ Über den Kiemen-apparat und das Zungenbein, 1832, p. 53.

|| Anat. Comp.

¶ The supplemental gill, like the thyroid gland, never derives a branch from the branchial artery; injection driven by the bulbus arteriosus never directly reaches it; but it admits of ready and complete injection by the systemic aorta.

organs in respect of their vascular supply; both deriving their afflux of blood from the first branchial vein, both rendering it up again by the readiest channel toward the heart, both as it were participating in the cerebral circulation.

But (it may be contended) this arrangement, which is comprehensible for the gland, is not equally so for the gill; why should this organ, which, in regard of structure at least, is clearly branchial, derive its supply of blood from a stream no longer requiring aëration? It cannot assist the respiratory process, which is already accomplished for the blood arriving there: it cannot do more than maintain the previous oxygenisation of the fluid which traverses it. I can conceive no other theory for the supplemental gill, in agreement with the preceding facts, than one which interprets it as a diverticular appendage to the first branchial vein, and contemplates its uses in reference to the parts supplied by that vessel.

Such then is the organ which,—obtaining the same nutritive supply as the thyroid gland, and occupying a correspondent position,—found only where that gland is absent, absent only where *it* is found,—may fitly be considered as its partial and rudimentary representative*.

The general results of the preceding inquiry are as follows; viz.

1. The thyroid gland, or an organ representing its place and office, may be found in *all vertebrate animals*.

2. It does not appear (as is the case with some organs) to belong to these animals, merely in behoof of the greater *general* completeness of their organization; but seems to have particular reference to that *specific character*, which binds them together as a natural section of the animal kingdom,—namely, the aggregation and more perfect development of their nervous centres; for

3. The gland, shifting its position most variously, yet always maintains an intimate *relation to the vascular supply of the brain*; always is so nourished that it can alternate a greater or less nutrition, according to the activity or repose of that nervous centre.

4. The organ, which in certain fishes represents a rudimental form of the thyroid, is plainly a mere *diverticulum* to the cerebral circulation: in the remaining fishes (where a more perfect thyroid exists), as likewise in the ascending scale of vertebrate animals, there is no essential change from the vascular organization of the branchiola; there is simply the super-addition of a glandular structure. The thyroid is but a higher development of the branchiola: what was a mere capillary plexus, now has gland-cells intermingled with its texture. Probably then the use of the secretory actions occurring in the thyroid gland is to be found in harmony with the obvious

* The Sturgeon, in addition to its thyroid, has a very small supplementary gill; so small, however, and so rudimentary, that this fish cannot be considered an exception to the general rule, but rather as an additional confirmation of its accuracy.

intention of its vascular supply; as the latter is diverticular, so we may expect the former to be vicarious, or alternative.

Such are the conclusions which Comparative Anatomy may warrant, and beyond these the proposed scope of the present paper does not permit me to advance. I would but in ending remark, that the views here suggested seem to me to receive equal sanction when contemplated in the light of the other physiological sciences. The peculiarly occasional and intermitting character of the cerebral functions,—the morphology of the thyroid gland, and its evident adaptation (as I have elsewhere shown) for a merely temporary, and, as it were, alternative secretion,—the known ability of arteries to regulate and proportion the supply of blood transmitted through them,—the diseases of the gland,—its turgid throbbing in hysterical lipothymia,—the mysterious relation of goître and cretinism;—these are topics on which it would be inconvenient now to dwell, but a glance at which is sufficient to show that comparative anatomy by no means exhausts the available arguments for the connexion suggested.